

Constructivist Research in Educational Technology: A Retrospective View and Future Prospects

Inae Kang

Kyunghee University

Jeong-Im Choi

Kwandong University
Korea

Kyungwon Chang

Kyunghee University

Along with a socially urgent impetus for revolutionary reform of an educational environment appropriate to the 21st century society, constructivism is highlighted in various fields related to education as an alternative educational ideology and approach. Despite its radical shift from traditional learning environments, and the diverse interpretation and understanding among scholars on the nature of constructivism, constructivism surely has brought out meaningful changes and developments in understanding how people learn. In light of this context, the present study aims to retrospectively review the last decade of constructivism, which will be followed by a brief prospective on its future in the next decade, simultaneously taking into account expectations as to how constructivism can stand firm as a theoretical basis for the digital age.

Key words: constructivism, constructivist research, constructivism in Korea

Introduction

Background

Along with a socially urgent impetus for revolutionary reform of an educational environment appropriate to the 21st century society, constructivism is highlighted in various fields related to education as an alternative educational ideology and approach in Korea as well as other countries.

Constructivism raises many issues and questions for both scholars and practitioners due to its radical shift from the traditional learning environment to a new paradigm. In particular, since Korean is a strongly traditional educational

environment, constructivism presents a dramatic challenge to Korean researchers and practitioners in all aspects of education. Furthermore, the diversity and differences among scholars on the nature of constructivism has caused a great many misconceptions and some degree of confusion in studies on constructivism.

However, the sheer novelty of and the theoretical freshness of constructivism, whether it draws either on genuine interest or on reluctant yet impulsive choice, has led people to put into practice ideas based upon an often incomplete understanding of constructivism. Therefore, constructivism has had the tendency to be understood more in terms of a teaching method or at best a teaching theory rather than an epistemologyⁱ which centers on what people come to realize, and what is knowledge, truth, or reality.

In this context, our study aims to provide a retrospective and prospective review as to how constructivism has been and will be implemented in both the last and next decade, while putting more emphasis on the past track record of constructivism in educational and associated fields.

Inae Kang, Graduate School of Education, Kyunghee University, Korea; Jeong-Im Choi, Education Technology, College of Education, Kwandong University, Korea; Kyungwon Chang, Center for Teaching and Learning, Kyunghee University, Korea.

Correspondence concerning this article should be addressed to Inae Kang, the Graduate School of Education, Kyunghee University, 1 Hoegi-dong Dongdaemun-gu, Seoul, South Korea (Zip code:130-701). e-mail: iakang@khu.ac.kr

Research Method

The purpose of the study is to present issues and trends related to constructivism in educational technology manifested over the last decade and to identify and plot trends for the next decade. For the purposes of this study, a literature review on constructivist research is employed as the research method, while the process consists of the following four stages: 1) Problem formulation, 2) Literature search, 3) Data evaluation, and 4) Analysis and interpretation (Cooper, 1998).

Problem formulation. The research problems of this study are formed as follows: 1) to examine the characteristics of the constructivist approach in the Korean educational technology field over the last decade, which is then compared with those in other countries; 2) to investigate the future of constructivist approaches over the next decade.

Literature search. The literature review on constructivism over the last decade was based upon a few representative journals of the educational technology field which includes two Korean journals (Korean Journal of Educational Technology, Korean Journal of Educational Research) and three international journals (Educational Technology, Educational Technology Research & Development, British Journal of Educational Technology).

Since the debate on constructivism in the educational technology field, in fact, only became truly active in 1991 when Educational Technology (hereafter, ET) published a special issue on constructivism, the data for the present study is mainly limited to the articles from 1990 to 2006. In total, 385 articles were analyzed including 100 articles from Korean journals and 285 articles from international journals (Refer to Table 1).

Data evaluation. In order to enhance the validity of data analysis and classification, the authors of this study follow the steps of (1) categorizing keywords or key concepts of constructivism from the journals mentioned above, (2) calculating and comparing the coefficient factor among the authors, which is .93, (3) negotiating their individual views on the classification, (4) modifying and developing the criterion on classification, and finally, categorizing the literature according to the criterion on classification.

Analysis and interpretation. Data analysis in this study was mainly content analysis based upon the criterion of classification. Content analysis, according to Stemler (2001), is a powerful data reduction technique. Its major benefit comes from the fact that it is a systemic, replicable technique for compressing many words of text into fewer content categories based on explicit rules of coding (Stemler, 2001). Excel 10.0 is employed as the data analysis tool.

Table 1
Numbers of Articles Analyzed

Journal	year	Number of articles	Number/ year	Publication Institution
Korean Journal of Educational Technology	1994-2006	77	4	The Korean Society for Educational Technology
Korean Journal of Educational Research	1994-2006	23	4	The Korean Society for the Study of Education
Educational Technology	1990-2006	149	6	Educational Technology Publications
Educational Technology Research & Development	1990-2006	74	4	The Association for Educational Communications and Technology
British Journal of Educational Technology	1990-2006	62	5	British Educational communications and Technology Agency

Constructivism in Retrospect

Overall Trends in the Past

Even though different or conflicting opinions may be raised in terms of the historical path of constructivism (Mahoney, 2004), the first study on constructivism was *Media and technology in education: A constructivist view* by Fosnot in 1984. In this article, Fosnot suggests constructivism as an alternative view to pursue media research. However, it was the special issue of ET in 1991 that, in a real sense, triggered the heated debate among scholars which in turn may be categorized into two camps; those of the anti-constructivists and pro-constructivists respectively. Since then, constructivism has been a major research issue, still leading to intensive debates on constructivism and traditional educational concepts.

In the meantime, constructivism was introduced to

Korean society in 1994 by the articles of *A master plan of instructional design based on cognitive apprenticeship* (Jo & Lee, 1994) and *Trends and issues in the field of instructional systems design* (You, 1994), which were followed by many other articles on constructivism. Table 2 shows chronologically the number of articles related to constructivism published in the above mentioned journals both in Korea and other countries.

As Table 2 shows, many studies on constructivism have been published almost every year, and the gradual increase of the total number of published articles in these journals directly indicates growing popularity of constructivism among researchers.

To analyze which key terms or issues in the field of constructivism are studied most, the articles selected from the journals are categorized in Table 3. The list of keywords for this analysis is derived from several discussions among the three authors of this paper. In categorizing the keywords,

Table 2
Numbers of Articles Published in Each Year

Year	Korea				International				Total	%
	KJET	KJER	Total	%	ET	ETR&D	BJET			
1990	0	0	0	0.0	0	0	1	1	0.4	
1991	0	0	0	0.0	18	1	1	20	7.0	
1992	0	0	0	0.0	0	2	5	7	2.5	
1993	0	0	0	0.0	12	3	2	17	6.0	
1994	4	1	5	5.0	26	4	1	31	10.9	
1995	2	0	2	2.0	5	2	1	8	2.8	
1996	5	1	6	6.0	2	7	1	10	3.5	
1997	4	1	5	5.0	0	7	4	11	3.9	
1998	6	4	10	10.0	8	4	4	16	5.6	
1999	7	2	9	9.0	5	6	1	12	4.2	
2000	7	1	8	8.0	5	0	1	6	2.1	
2001	4	3	7	7.0	16	1	2	19	6.7	
2002	5	1	6	6.0	8	5	3	16	5.6	
2003	10	2	12	12.0	8	8	3	19	6.7	
2004	8	2	10	10.0	7	6	12	25	8.8	
2005	7	2	9	9.0	20	5	8	33	11.6	
2006	8	3	11	11.0	9	13	12	34	11.9	
TOTAL	77	23	100	100.0	149	74	62	285	100.0	

the authors of the paper had to confront a number of problems: (1) to determine the list of keywords; (2) to review the entire article to verify if the terms used in the titles were concerned with constructivism; (3) to select a

representative keyword among many issues dealt in an article.

The result of this work among the authors is Table 3, showing the list of keywords (or key concepts) on

Table 3

Keywords Used in the Title of the Articles on Constructivism from 1990 to 2006

Keywords	Korea					International			
	JET	KJER	Total	%	ET	ETR&D	BJET	Total	%
Constructivism	19	9	28	28.0	17	19	18	54	18.9
Paradigm									
Post –modernism, feminism critical theory, interpretivism, Functional Contextualism	0	0	0	0.0	16	6	0	22	7.7
Knowledge									
knowing, knowledge construction, learning	2	0	2	2.0	6	0	2	8	2.8
Vygotsky									
Contextualize, Authentic	0	2	2	2.0	5	0	1	6	2.1
Situated learning									
Facilitating, Coaching	6	2	8	8.0	28	11	1	40	14.0
Scaffolding									
Ill-constructed, Ill-defined	3	0	2	2.0	4	5	5	14	4.9
Complex									
OELE	1	0	1	1.0	1	1	1	3	1.1
Learning Environment									
Collaborative	2	0	2	2.0	10	4	0	14	4.9
Cooperative, Group, Community	9	3	12	12.0	29	17	22	68	23.9
Learner-centered									
User-centered, student-centered	0	0	0	0	7	1	5	13	4.6
Reflective									
Hypertext	2	0	2	2.0	2	0	0	2	0.7
Hypermedia	5	0	5	5.0	5	2	0	7	2.5
Problem Solving									
Critical thinking, Inquiry Learning	7	1	8	8.0	1	1	4	6	2.1
Problem Based Learning									
7	5	12	12.0	3	5	1	9	3.2	
Project Based Learning									
6	0	6	6.0	2	0	0	2	0.7	
Action Learning									
1	0	1	1.0	3	0	0	3	1.1	
Problem Solving Scenario									
1	0	1	1.0	0	0	0	0	0.0	
Cognitive Flexibility									
0	0	0	0.0	2	0	2	4	1.4	
Goal Based Scenario									
2	0	2	2.0	8	0	0	8	2.8	
Cognitive Apprenticeship									
1	0	1	1.0	0	2	0	2	0.7	
TOTAL	77	23	100	100	149	74	62	285	100

constructivism, and the numbers of individual keywords examined among the constructivist papers.

Additionally, Table 3 distinguishes the research foci and trends between Korea and other countries. In Korea, the most popular topic was 'constructivism' (28.0% of the total articles published in Korea), 'PBL' (12.0%) and 'collaborative learning' (12.0%), while 'collaborative learning' (23.9%), 'constructivism' (19.3%), 'situated learning' (15.8%) seem to be the most popular in other countries.

Although the topics of 'constructivism' and 'collaborative learning' are commonly popular in both Korea and internationally, nevertheless, differences are noticed. That is, certain constructivist instructional models, such as project based learning (PBL), GBS, etc., are addressed in 23% of the total articles in Korea and 12% in other countries, respectively. Moreover, the most popular instructional model in Korea is PBL (12.0%), as opposed to situated learning (14.0%) in other countries. Other statistical differences between Korea and other countries are as follows: paradigm (0% vs. 7.7%), learner-centered (0% vs. 4.6%); problem solving (12% vs. 3.2%); project based learning (6.0% vs. 0.7%).

The difference between Korea and other countries in terms of their research tendencies and concerns indicate that research on constructivism in Korea lends itself towards what are arguably it's more 'practical aspects,' while other countries keep a more balanced approach between theory and practice. A more detailed analysis in the following section will support our temporary contention regarding the different research tendencies between Korea and other countries.

Chronological Analysis of the Research Trends

The research trends or themes on constructivism clearly show a kind of transitional shift along with the advent of IT-enhanced learning in the digital age. As assumed, IT or media in the current age became a very important factor influencing research themes and issues in general and on constructivism as well. The following will provide more details on this.

The 1990s (1990-1999)

International research trends 1: A balanced approach both to the theory and practice of Constructivism. The

special issues on constructivism by *ET* (1991, 31(5) & 31(9)) are considered the starting point which triggered academic concern, interest and discussion on constructivism. Actually, the data comparing the numbers of research papers related to constructivism among three journals (*ET*, *ET R & D*, *British Journal of Educational Technology*) clearly indicates that *ET* is the journal which has most actively dealt with issues related to constructivism. Table 4 briefly summarizes how and what issues in the field of constructivism have been examined during the last decade in other countries.

The basic premise of most research on constructivism in other countries approaches constructivism as a new emerging paradigm of education. As Table 4 shows, *ET* published two special issues focusing exclusively on constructivism: The first instance was in 1994 in which constructivism was compared and interpreted alongside

Feminism, Marxism, Habermas' theory, Critical Theory, and Post-modernism; the second instances are both in 1993 and 1994 when 'Situated learning' as another term of constructivism was discussed in detail. Of course, even when constructivism is discussed as an alternative paradigm and approach to educational environments, practical issues dealing with the relationships between constructivism and ID or 'Goal-Based Scenario' (GBS, hereafter) as a representative learning model of constructivism, simultaneously, are also discussed.

The similar tendency of balancing theory with practice of constructivism is noticeable from *ET R&D* which, as a more academic and professional journal than *ET*, also seriously deals with issues on constructivist epistemology (e.g., the article of *Objectivism verse constructivism: Do we need a new philosophical paradigm?* by Jonassen, 1991b), perspectives (especially, in the name of 'Situated Learning'), and the relationships between constructivism and ID.

Starting from the mid 1990s, however, the emphasis of the research into constructivism gradually started to move from a 'theoretical or philosophical review and reflection' toward the application of constructivist concepts and ideas in various settings, coupled with media or ICT-related issues such as multimedia, open-ended learning environments, integrated learning systems, and interactive learning environments. At the same time, various constructivist instructional methods, such as Problem-Based Learning, Project-Based Learning, Inquiry-Based Learning started to appear in the major journals.

Table 4
Main issues on Constructivism in the International Journals

YEAR	ET	ETR&D	BJET
1991	Debate between constructivism and objectivism(18)	Debate between constructivism and objectivism(1)	Computer simulation for problem solving(1)
1992	(0)	Application of constructivism in micro world and curriculum reform(2)	Application of the idea of constructivism such as Student-centered learning, Flexible learning, Collaborative simulation Media-oriented using simulation, hypercard, computer-based environment(5)
1993	Situated Learning(12)	Constructivism and Situated learning for ID, Collaborative learning(3)	Student-centered, collaborative learning(2)
1994	Situated Learning, Anchored learning, Relationships with other related theories [post-modernism, Feminism, empowerment, etc.], GBS(26)	Situated learning theory, Collaborative learning environment, Implication of Constructivism for media and software design(4)	Using the term of constructivism for hypercard environment(1)
1995	Constructivist learning environments, Constructivism with IT (virtual world), PBL(5)	Situated learning theory, Effect of collaborative learning(2)	Computer supported collaborative learning(1)
1996	Constructivism with Hypermedia, Constructivist learning materials(2)	Collaborative learning for distance learning, Application of constructivism to computer, multimedia, ID, and learning environment(7)	Collaborative learning with multimedia(1)
1997	(0)	Situated learning(SL) theory, ID model for problem-solving, Application of constructivism and SL to learning environment, computer system and www (7)	Implication of constructivism for Visual literacy, Student-centered, flexibility, collaborative learning with multimedia, (4)
1998	Constructivism with hypermedia, on-line community, constructivist learning environments (conversation, interaction, interactivity)(8)	Implication of constructivism for the design of ET, PBL, Authentic project(3)	Implication of constructivism for ID of multimedia, computer-based learning environment, higher-education (4)
1999	Paradigm, constructivism with virtual simulation & software, Collaboration(5)	Inquiry learning (information seeking), Activity Theory, Application of constructivism to hypermedia and simulation(6)	Application of constructivism to multimedia environment(1)
2000	Constructivism with Web & on-line learning, social-cultural perspectives(5)	(0)	Effect of constructivism on student's perception(1)
2001	Constructivism with e-Learning (interactivity, collaboration, community of practices), Vygotsky with WBL, epistemology with WWW(16)	History of ID(1)	Implication of constructivism on CBL, Concept-mapping(2)
2002	PBL with IT, the nature of learning (participative learning, activity), virtual community of practice(8)	Application of constructivism in divers forms such as scaffolding, advisement, pedagogical agents to simulation, multimedia, problem solving learning environments Collaborative knowledge building(5)	Constructivism for online learning, electronic information resources(3)
2003	Social constructivism with CSCL, Socialization with online learning, Collaborative learning with virtual reality. Cognitive Flexibility Theory, Beyond constructivism, integration of learning theory(8)	Scaffolding on problem-solving and PBL, Collaborative learning for problem solving, online-course, activity learning, electronic learning environment, Student-centered learning environment (8)	Application of constructivism to Computer-based learning environment (3)
2004	Socio-cultural view, dialogue, collaborative learning, cultural diversity, science of learning, Self-directed learning(7)	Scaffolding on problem-solving, Activity theory Collaborative learning for online learning environment Implication of constructivism for organizational learning (6)	Internet as an Epistemological tool Implication of constructivism to teacher education, Critical thinking Focus on collaborative learning and scaffolding for online & web learning, Vygotsky's theory, SL for simulation (12)
2005	Collaborative learning with technology, ICT tool, distance, Facilitating collaboration, Authentic learning environment (20)	Hypermedia and problem solving, Cognitive Apprenticeship and collaboration, Problem based learning and self efficacy (5)	Learning Community, Learner-centered collaborative (distance) learning, problem solving, Design criteria for authentic learning environment(9)
2006	Collaborative learning in k-12, university, and workplace, Situated learning for real world (9)	Functional Contextualism, Contextualism and constructivism, Problem solving, Collaboration in online (13)	Community for knowledge creation, Situated learning in K-12, university, and lifelong environment, Facilitating in a team collaboration, Collaboration in learning networks, Problem Solving, (13)

International research trends 2: Hypermedia meets constructivism. It was the advent of IT or Media (more specifically hypermedia) which became a barometer to classify either research on constructivist epistemology and philosophy, or practical approaches on IT-mediated constructivism. In 1995, *ET* gave its primary focus to studies on CBT using hypermedia. Due to the characteristics of hypermedia where the locus of control shifts from the system to the learner in terms of the selection and links of nodes, hypermedia is interpreted as a representative metaphor of constructivism where the subject of learning is shifted from the teacher to the student, placing an emphasis upon the autonomous, reflective, and responsible role of the student.

The studies on multimedia with constructivism also became popular in the *British Journal of Educational Technology* (Hereafter, *BJET*). *BJET*, which used to be a rather media-oriented journal, began to publish articles on the design of computer-based learning, hypermedia, and computer simulation, all of course, with a constructivist perspectives approach.

The common tendency to relate constructivism with IT or media found in all three journals (*ET*, *ETR&D*, *BJET*) has continued even to the end of the 1990s, including the issues on the world wide web, internet, and multimedia learning environments.

Korean research trends: A greater focus on practice-oriented research. As for Korea, the recent educational discourse is dominated, as in other countries, by constructivist terminologies and principles, starting from the mid 1990s to the present along with the advent of IT (Refer to Table 5).

Constructivism as it emerged in Korean educational society can also be divided into two stages, as in other countries. The first stage, during the mid to late 1990s, seems to focus on the introduction to construction. Interestingly enough, however, even the first article on Constructivism published in Korea by Jo and Lee(1994) is about the practical implications of cognitive apprenticeship, not about the theoretical review on constructivism itself. Later, even when several articles in the mid 1990s addressed constructivist epistemology (Kang, 1995a; Kang, 1995b; Choi, 1998; Lee, 1996; You, 1994), most research articles

and studies have rushed into actual practice of the constructivist approaches in the classroom or other educational settings (Lee, 1994; Lee, 1996; Choi, 1996; etc.). A higher priority before a firm understanding and discussion on the epistemological or philosophical aspects of constructivism is given to constructivist learning models such as 'Situated Learning' (Choi, 1996), 'Goal-based Scenario' (Lee, 1996), 'Problem Solving Scenario' (Lim, 1998), 'Project based Learning' (Jo, 1999) and 'Problem-Based Learning' (Kang & Kim, 1998; Lee, 1997).

This practice-oriented research trend in Korea is assumed stem from two sources, i.e., the Korean researchers who introduced constructivism with concrete cases and examples applied in American educational settings, as well an urgent societal and government need for educational reform. This situation, peculiar to Korea, therefore, resulted in the skipping of a more serious discussion on and a more general concern with the foundations of constructivism, while rushing immediately into practical research.

From the early 2000's to the present

International research trends: Constructivism embedded into online learning environments. In early 2000, when every journal was full of topics on IT such as Web-Based Learning (hereafter, *WBL*), distance learning, online learning, e-learning, researchers started to refocus and reexamine constructivism as a theoretical foundation in an age where learning was becoming increasingly impacted through technology. Technology in the 2000s has reorganized how we live, how we communicate, and how we learn. Learning needs and theories that describe learning principles and processes should be reflective of underlying social environments.

In *ET*, the research on hypermedia shifts its concern to the relationships with *WBL* (or more recently, e-learning). Along with features of hypermedia which emphasizes the autonomy of information management (selection and links) and the enormous amounts of information involved, *WBL* goes further to include more diverse IT tools and functions such as multimedia, communication, networking, and interaction. Studies on *WBL*, therefore, came to reinforce the importance of constructivist approaches and principles in the *WBL* environments.

For example, the articles in the 2000s on constructivism in *ETR&D* mostly addressed the issues of collaborative

Table 5

Main Issues on Constructivism in Korean Journals

YEAR	KJET	KJER
1994	Introduction of constructivism as theoretical background of cognitive apprenticeship, and problem solving, Paradigm shift(4)	Theoretical review of constructivism in educational evaluation(1)
1995	Discussion on cognitive and Social constructivism, constructivist principles for learning and instruction(2)	(0)
1996	Introduction of the cases of constructivist models (mainly in American educational settings) : cognitive apprenticeships, cognitive flexibility, GBS, and situated learning, Implication of constructivism for internet (5)	Theoretical review of Vygotsky's ZDP(1)
1997	Implication of constructivism for distance learning and problem solving. The effect of PBL compared with lecture (4)	Theoretical review of situated learning(1)
1998	Application cases : Problem Solving Scenario, PBL Theoretical review of constructivism (6)	Application of constructivist principles Theoretical review of constructivist learning environment(4)
1999	Application of Authenticity, Problem solving, Collaborative learning, PBL, Project-based learning in WBL(7)	PBL(1)
2000	Application of constructivism for the design of WBL environments, PBL, collaborative learning and Inquiry learning(7)	Theoretical review of authenticity(1)
2001	Application of constructivism for design of WBL environments Inquiry learning and collaborative learning (4)	Implication of Constructivism for the museum education and Online PBL(3)
2002	Application of PBL, scaffolding, GBS, ill-structured problem situations to e-Learning (5)	Theoretical review of Constructivism (1)
2003	Application of constructivist principles and models to e-Learning, Theoretical review of constructivism : Reflection, knowledge construction, constructivist learning theories such as activity theory, situated cognition theory, distributed cognition theory, ecological psychology (10)	Theoretical review of PBL Collaborative learning in the WBL(2)
2004	Application of constructivism in divers forms such as collaborative learning, Project based learning, scaffolding, CSCL, online PBL, and action learning, Theoretical review on the design principle of PBL(8)	Application of Vygotsky(2)
2005	Collaboration and community in online, Problem-based learning, Team building for collaboration(7)	Problem-based learning(2)
2006	Scaffolding in CSCL, Tool for reflection, Reflective thinking, Situated learning (8)	Problem solving, Collaborative learning, Reflection(3)

learning, scaffolding, knowledge-building in the multimedia or computer-based learning environments, authentic learning resources, interactivity, etc. Likewise, *ET* in the 2000s also included a great deal of research on IT-related research and studies, while the aspect of 'high touch,' not to mention that

of 'high tech,' gradually gained the attention of researchers. The researchers on this trend mostly contend that the theoretical basis of their IT practices stem from 'social constructivism,' or 'socio-cultural perspectives' (Down, 2005; Lave & Wenger, 1985; Vygotsky, 1978).

These trends imply that constructivism became a grounded theory for the IT-based learning environments including e-learning which are, technically, embedded with the feature of learner-centered learning environments. In other words, the recent research on IT-mediated learning matches its theoretical grounding with constructivism, or, more specifically, learning theories of scaffolding, Problem-Based Learning, Project-Based Learning, and Situated Learning.

Korean research trends: The transformation of constructivism as the theoretical basis of e-Learning. The enormous impact of IT upon the educational system as well as learning seems the same even in Korea. Constructivism, which first drew attention to itself as an alternative learning environment and approach from the mid 90s, is gradually preparing its own evolution and transformation for the onset of the 2nd generation of constructivism which seeks to function as the theoretical basis of e-learning, or IT-enhanced learning environments in the digital age.

Even though the marriage between constructivism (theory) and media (tool) such as video discs, the internet, CSCL, the web, and virtual reality is mentioned only sparsely by several early researchers before the 2000s, the advent of WBL(or e-learning) reaffirms the importance of constructivism as its theoretical foundation (Bonk, 2004; Duffy, 2004). For example, various cases of constructivist models in web-based environments have been presented in the 2000s, such as *Constructivist learning principles in the web*(Kang, 2001; Kang & Lee, 2000; Kwon, 2000), *Reflection in computer supported collaborative learning environments*(Lee, 2003; Lee & Kim, 2003; Park & Kang, 2003), *Web based Project-based learning* (Jo, 2000; Lim, Lim, Choi, & Kim, 2004), *Web based PBL* (Choi & Jeon, 2002; Choi & Kim, 2003; Choi & Sung, 2004), and *Web-based inquiry learning*(Kang & Han, 2000; Kang, 2001; Lim, 2003), and so on.

It is interesting to note that constructivism, introduced first as an alternative learning environment to traditional learning environments, must now confront many critiques both in terms of its own epistemological assumptions and its impracticality in reality. However, the claim that constructivism is maintained as the theoretical basis for e-learning or IT-mediated learning environments (especially in terms of WBL, online communities, and CSCL), tends to be

accepted more unanimously from most related researchers.

In conclusion, constructivism in Korea is yet to be perceived as a concrete teaching methodology rather than as a philosophy, or learning theory. This phenomena, however, is not desirable, when viewed from the assumption that the future of our educational system will heavily rely upon the utilization of IT (for example, in the form of e-learning, M-learning, or U-learning) strongly based upon learner-centered learning theory. The heavy reliance on IT (i.e., 'high tech') without a firm understanding of the associated learning theory (i.e., 'high touch') might prove to be unstable; much akin to a house built upon sand. A more mature and deeper understanding of constructivism as the basis of IT-mediated learning environments, therefore, is absolutely necessary to build sound educational environments appropriate to the 21st century. However, the fact that Korea has a relatively weak foundation in terms of the constructivist approach, simultaneously, indicates the preferred direction for the next step be recognized.

Prospects of constructivism in the 21st century

It is risky to predict what constructivism in the 21st century will look like, considering the fact that contemporary society is defined as complex and unpredictable due to its rapid development and changes occurring in virtually every field of human activity. Yet, the current trends of educational fields, according to a great deal of research on this area (Danish Technological Institute, 2005; EDUCAUSE, 2005; Strandvall, 2003), can be divided into several themes,ⁱⁱ some of which overlap each other, yet, and which obviously reflect and embrace the constructivist spirit and associated themes.

When we express the current dimensions of our worlds and experiences, it is a 'dizzying chaos,' yet, at the same time, 'the stirrings of what might be called an integral movement' (Mahoney, 2004) also exist. Unity and diversity are being integrated in ways that indicate the traditions of holism. Dialogues are taking place that suggest an evolutionary leap in our understanding of what it means to be learning, to be a community, to possess IT- embedded learning. The emphasis is on connection rather than separation. Moreover, constructivism is part of this process, acquiring continuing encouragement from a diverse, emergent, and embracing spirit.

The following will explore why, how, and in what form

constructivism, even in the next generation, should exist, expand, and evolve.

Embodying Constructivist Spirit through Learning Technologies

Constructivism, ever since its encounter with IT in the early 1990s (i.e., hypermedia, WBL, on-line learning, and recently, u-Learning), is generally considered the theoretical basis for emerging IT-enhanced learning and teaching (to name a few, Bonk, 2004; Downe, 2005; Duffy, 2004). Of course, those pedagogical approaches such as learner-centered, ownership, problem-solving, dialogue, team-oriented learning, interpersonal skills, and scaffolding, are, sometimes, mentioned as desirable approaches for e-learning (or virtual learning community, technology-enhanced learning environments, or u-Learning) even without any direct word of constructivism or constructivist approaches (to name a few, Banathy, 2003; Elijl & Pilot, 2003; Melon, 2003; Reigeluth & Beatty, 2003; Shutt, 2003; Spitzer, 2003). However, it is easily seen that the learning and teaching strategies or principles underlying those pedagogical approaches unavoidably undermine constructivist perspectives of learningⁱⁱⁱ.

The constructivist perspectives or spirit which became the criterion to classify any article as a constructivist camp is, first of all, to see knowledge as constructed, not given. According to Bork (2000) the important factors in the new learning paradigm are as follows: 1) highly interactive-like conversation, 2) individualized (learning style or individualized attention), 3) adaptive to students' current needs 4) creative (constructing, discovering), 5) problem-solving, rather than being memory-based, 6) highly interactive distance learning for internal motivation, 7) peer learning in small groups along with parent or others'

involvement to their learning circles (pp. 78-80).

Much literature on newly emerging technologies (such as PDAs, Personal PC, Smart Phone, Game Consoles, WBI, LMS, wiki, weblogs, instant messaging, IRC, MUD) defines the characteristics of these learning technologies as follows: 1) social interaction, 2) individuality, 3) communication, 4) context-sensitivity, 5) connectivity (Bryant, 2003; Klopfer, Squire, & Jenkins, 2002; Naismith, Lonsdale, Vavoula, & Sharples, 2005; Suter, Alexander, & Kaplan, 2005).

Now, it is very clear to determine direct partnership between the constructivist perspectives mentioned above and the characteristics of the new learning technologies. Moreover, considering that such learning technologies will take a pervasive and 'more central' position in the next-generation learning environments (Reigeluth & Beatty, 2003), constructivist perspectives resonate with the characteristics of learning technologies must be highlighted and reexamined as a theoretical basis for technology-enhanced learning environments in the future.

Constructivism as a Pedagogical Model for the Net-Generation in the Digital World

Educational history shows that social needs and educational environments mutually influence changes or development or paradigmatic shifts. Likewise, the social needs required for the learner in the 21st century (refer to Table 6) indicate, in one sense, the future direction of learning and teaching in the 21st century, as well as the close relationships with constructivist perspectives.

Most of the skills identified above might be difficult to learn in traditional learning environments which are generally based upon objectivist principles (i.e., emphasis on memory, recall, individual learning, & information-transfer

Table 6

Learning Skills for the 21st Century

Information and Communication Skills	• Information & Media Literacy	• Communication Skills.
Thinking and Problem-Solving Skills	• Critical Thinking & Systems Thinking • Problem identification, formulation and solution • Creativity and intellectual curiosity	
Interpersonal and Self-Directional Skills	• Interpersonal and collaborative skills • Accountability and Adaptability	• Self Direction • Social Responsibility

model), while constructivist principles where learner-initiated, and directed, problem-based, group-based learning environments are emphasized seem more appropriate to deal with those skills. In other words, social needs in the 21st century quite obviously require the development of constructivist learning environments.

What, then, of the learners in the 21st century? The characteristics of internet-generation, according to Nasseh (2001), are listed as follows:

- They are comfortable with and eager to contribute to the knowledge bases of the digital community.
- They are innovative and demand empowerment in the processes of learning and learning activities.
- They are curious and are natural researchers in the discovery of learning resources from the global network.
- They are generous and share their knowledge easily with the digital community, teachers, students, and institutions at the global level.
- They are adaptable to changes in computer and communication technologies and their applications in life, education, and work.
- They are confident and enjoy the local, national, and global digital journey. They pursue opportunities for discovery, creation, innovation, and experimentation.
- They have a passion for the creation of technology-based learning activities and digital communities.
- They are ambassadors who will bring cultures, countries, and religions closer by digital communication, collaboration, and the sharing of knowledge.
- They respect digital communities and society, and develop standards and procedures for digital communication and collaboration.
- They demand an empowered environment for the design of learning process and learning activities.
- They have global orientation with resources and communities.
- They have individual styles, but fit perfectly in the digital communities in local, national, and global levels.
- They prefer physical isolation in social and learning activities.
- They are the most socialized generation in the digital world and most isolated generation in the physical

world.

In summary, the main characteristics of this generation are sharing knowledge, the ability to discover, adaptability, and being comfortable with the digital world. The talents and imagination of this generation can help an institution to integrating technology in the learning activities. The deep involvement of this generation in the global network and collaborative work will help provide unity among cultures, religions, and races. Its global interaction is the hallmark of educational and social activities of the net-generation in the 21st century.

Currently, these characteristics of the net-generation, in turn, imply what the learning model for the next generation should be like. In other words, the paradigm of 'information transfer' cannot work for them any more. What, then, is the alternative? Once again, the answer may be the constructivist learning environments where learners' competency as a creative, autonomous, collaborative, and problem-solving learner in this complex, rapidly changing, digital world are facilitated and valued, and where the eventual goal of their learning is placed on bettering performance and a viable understanding of the world. Utilizing context-sensitive, collaborative, individualized, and socially interactive learning technologies, on one hand, and at the same time, infusing pedagogical support with constructivist approaches, on the other, the learners are better-prepared to become better performers in the digital era.

Post-Constructivism: Evolution to Learning Sciences

As mentioned before, one of the main trends of technology-enhanced environments is blended learning (Danish Technological Institute, 2005; Malt, Deblois, & the EDUCAUSE current issues committee, 2005; Strandvall, 2003). Blended learning, according to Singh (2003), encompasses diverse dimensions such as 'blending offline and online learning,' 'blending self-paced and live, collaborative learning,' 'blending structure and unstructured learning,' 'blending custom content with off-the-shelf content (i.e., generic),' and 'blending learning, practice, and performance support.' Blended learning, in this study, indicates the term of integration or convergence.

In a similar context, constructivism, in the age of convergence and integration, must contend with diverse

learning theories or approaches such as Multiple intelligence (Gardner, 1993), Brain-based learning (Caine & Caine, 2001), Experiential learning (Wight, 1993; Refer to [Figure 1]), Connectionism (Barabasi, 2002), Neuroscience (Sylwester, 1993), Control theory (Glasser, 1990), and Social cognition (Social constructivism) (Vygotsky, 1978). Despite the diverse names of each learning theory, most of these learning theories share many commonalities in terms of 'epistemology' (i.e., knowledge is constructed by the learner in the community of practices) or 'pedagogical perspectives' (i.e., autonomous, self-directed, collaborative learner in context-sensitive learning environments). Typically these new learning theories are considered to be one family under the umbrella of constructivist epistemology.

However, along with the advent of the renaissance age of learning technology in the 2000s, constructivism finds itself challenged in terms of the reexamination of its basic premises based upon the tradition of the social sciences. For example, a recent report from the National Research Council (Shavelson & Towne, 2002) calls for 'greater scientific rigor in educational research' (Winn, 2003).

In spite of the obvious benefits that constructivism has brought forth to current learning environments, problems with constructivism are also driven from those benefits, i.e., relativistic epistemology of knowledge construction, and the problems of how to deal with the complexity of the world.

Learning theories based upon natural science such as brain-based learning, connectionism, and neuroscience, therefore, came to gain attention as supplementary learning theories for constructivism in the digital age (Winn, 2003).



Figure 1. Experiential learning

Of course, the basic premises of these learning theories based upon the natural sciences are also in agreement with constructivists in the social sciences, suggesting that reductionism is not sufficient to explain the way the world works, and that learning is considered to be a self-organizing or emergent property of complex systems consisting of students and the environments in which they learn (Winn & Windschitl, 2002). What these learning theories purport is that the basic mechanism of learning is biological. When we learn something new, changes occur within our brains that can sometimes be made visible by such imaging techniques as MRI (Berninger & Richards, 2002).

Winn (2003) also in his recent article pointed out some of the weaknesses of constructivism as follows: 1) lack of focus on how learning occurs, 2) emphasis on the unique, not the common elements of what is learned and how, 3) a need to look at both the environmental and individual aspects of cognition, and finally 4) a need in describing how learning occurs (Winn, 2003). He further suggests that neuroscience and connectionism can supplement the lack of constructivism with a biological view of cognition (i.e., the view of adaptive learning; ecological view of coupling student and environments; and systemic view of learning).

However, Winn's persuasive and modest criticism of constructivism is also challenged, when Mahoney (2004) presents the history or the intellectual genealogy of constructivism tracing a path to Giambattista Vico (1668-1744), and Immanuel Kant (1724-1804). According to Mahoney (2004), Vico emphasizes the role of fantasy and myth in 'human adaptation.' Moreover, Kant emphasizes the power of patterns in our thinking. Johann Herbart (1776-1841), moreover, proposes the dynamic view of learning which is developed by Jean Piaget who describes knowing as a quest for a dynamic balance between what is familiar and what is novel. Piaget, according to Mahoney (2004), notes that we organize our worlds by organizing ourselves, i.e., the theme of 'developmental self-organization'.

The tradition of natural science embedded in the history of constructivism was detected even in 1996 when a society of constructivism in the Human Sciences was formed to encourage and communicate developments in theory, research, and practices, reflecting an appreciation for 'human beings as actively complex, socially-embedded, and developmentally dynamic self-organizing systems.' The society includes experts and scholars not only in psychology

but also from the fields of biology, history, linguistics, neuroscience, philosophy, physics, and political science (Mahoney, 2004).

Mahoney's views on the history of constructivism go beyond the persuasive defense of constructivism, when he associates constructivism with a 'learning science' (Refer to the special issues of *Educational Technology*, 2004, 43[3]): As the constructivist society is interdisciplinary, learning sciences are also 'multidisciplinary' (Koschmann, 2004) involving as they do 'community of practice' (Kolodner, 2004) including linguistics, neurobiologists, psychologists, philosophers, and psychologists (Barab, 2004; Duffy, 2004; Kolodner, 2004; Koschmann, 2004; Smith, 2004).

Moreover, according to Kolodner (2004), learning sciences "harvest theories of active, constructivist, and participatory learning to design software and learning environments and ways of educating that promote deep and lasting learning" (p. 37). Likewise, Smith (2004) also writes that "the field was influenced by work in situated cognition. . . . hence many research 'experiments' conducted by LS[learning sciences] take place in naturalistic settings" (p. 21). He continues to say that 'LS design researchers believe that learning is complex and messy when studied in context, making it difficult to develop successful interventions from a single, rigorous theory or methods. Instead, theories evolve from working in context and applying multiple strategies to make interventions 'work' (p. 24).

It is very clear, therefore, that learning sciences are basically rooted in the traditions, beliefs, philosophy, epistemology, and strategies of 'social constructivism' (Kolodner, 2004; Smith, 2004).

In conclusion, constructivism, encompassing many specialized fields relevant to the topic of learning^{iv}, has and is currently undergoing a wide and active evolution, and hence comes to terms with the 'learning sciences'. In this context, the future of constructivism will be as active and pervasive as the past and present. As the learners are 'actively complex, socially-embedded, and developmentally dynamic self-organizing systems' (Mahoney, 2004), constructivism also will go through 'on-going, self-referent or recursive' development or growth in 'living webs of relationships' in which a dynamic dialectical tensions are essential to attain 'ordering process' (Mahoney, 2004). The future state of constructivism, then, will flourish in the form

of the 'learning sciences' where technology is a very important tool to promote learning in powerful ways (Smith, 2004). The final term to describe the future of constructivism is, not 'beyond constructivism' (Winn, 2003) which emphasizes the weaknesses or limitations of constructivism, but rather 'post- constructivism' which promotes the expansion of constructivism in the form of the 'learning sciences'.

Notes

¹ The constructivist view in this study, in accordance with von Galsersfeld (1995), argues that knowledge and reality do not have an objective or absolute value, and, in relation to the concept of reality, it "is made up of the network of things and relationships that we rely on in our living, and on which, we believe, others rely on, too" (p.7). The knower interprets and constructs a reality based on his experiences and interactions with his environment. Therefore, rather than thinking of truth in terms of a match to reality, constructivism contends the notion of viability.

² The lists are, to name a few, as follows: mobile and pervasive technology, individualized, socially interactive technologies, blended, integrated learning, LMS, connectivity, digital collaboration, learning through simulation, game-based learning, learner-centered, engagement and interaction, and community.

³ Actually, one of the biggest problems for the authors of this paper, in conducting the analysis and collection of metadata concerning constructivism from related journals, was to determine whether constructivist terms in any article are pertinent without careful reading of the entire article, or whether an article is related to constructivism only by an unclear or obscure title.

⁴ For example, software designers, cognitive psychologist, social scientists, philosophers, neuroscientists, all of whom gather to learn more about learning itself, how to promote better learning, and how to promote learning more effectively.

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